Selected Problems of Passive House

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Abstract

The paper deals with project proposals, construction and exploitation of house in passive standard. Specific properties of building envelope in energy passive standard. Execution of additional thermal insulating system with heat bridge elimination. Evaluation of applicable design using non-traditional aluminium basis. Elimination of heat flows in window structure.

Keywords

Passive standard, window, thermal insulating.

Intorduction

Passive building is a building, which does not need supplying energy conventional system for ensuring thermal comfort. In order to achieve this, the heating demand of such building will be 90 % less comparing to common buildings. The specific heat demand (in kWh/(m^2.year)) is around 100 in common modern building, on average 200 in old block of flats, below 50 in low energy building and below 15 (kWh/(m^2.year)) in passive building. The specific heat demand below 15 (kWh/(m^2.year)) is a basic characteristic of passive building and it is proved by calculation. Window is a distinctive transparent building element in terms of construction and architecture, endurance against breaking, sun, heat, wind, cold and rain effects, or mechanical, fire, acoustic resistance, and alike. Nowadays, the window as a part of heat exchange building envelope structure is significant element in building energy concept (particularly in passive buildings). In window design, in terms of placement and glazing area size, it is important to look for the balance between the heat loss and solar gains. However, it would be misleading to think that the indoor climate - external climate interaction is affected only by glazing area size considering the transparent parts of building envelope. The correct solution of window structural parts and window embedding in building envelope is a relevant property of quality window.

Fig. 1 Geometry and design of a building realized in passive standard

Non-transparent parts of building envelope

Evolution of building construction requirements is an integral part of evolution of energy requirements for buildings. Roof thermal transmittance with recommended standard value of 0,2 W/(m^2.K) decreases in case of low energy building to 0,15 W/(m^2.K), and for passive buildings down to 0,1 W/(m^2.K). External wall thermal transmittance with recommended standard value of 0,32 W/(m^2.K) decreases in case of low energy building to 0,20 W/(m^2.K), and for passive buildings down to 0,15 W/(m^2.K). Ground floor thermal transmittance with recommended standard value of 0,25 W/(m^2.K) decreases in case of low energy building to 0,18 W/(m^2.K), and for passive buildings down to 0,15 W/(m^2.K). In the past, while designing the size and quality of thermal insulation for building structures, it was primarily necessary to ensure the hygienic criterion (condensation and fungi formation). The increase of need for showing the energy savings leads to enhancement of thermal characteristics of building structures. The fact that by correct material combination (in terms of structure moisture transport) as well as good thermals performance the problem of surface condensation and fungi formation is definitely solved is highly appreciated [1, 2].

Fig. 2 Part of the flat roof (to create space for the insulation of attic)

Fig. 3 Inappropriate anchorage of adhesive anchor is demonstrated on the left side and appropriate application is shown on the right side

Roofs for low energy and passive standards can be designed as sloping and flat ones, where appropriate thickness of thermal insulation, which should be in such cases for standard thermal insulating materials between 300 and 400 mm, is decisive. In application of new materials (e.g. on PIR foam basis) the thickness of thermal insulation can decline to approximately 260 mm. This material was also used in the flat roof. In the sloping roof the thermal insulation on mineral wool basis with heat bridge elimination was applied. The external walls were designed and realized as heavy structures. It means that POROTHERM 300 mm using contact thermal insulating system on polystyrene basis was applied. In such cases, when masonry external wall is used, it is inevitable to pay attention to applying appropriate anchorage system for thermal insulation (Fig. 3).

From the viewpoint of elimination of point heat bridges the special adhesive anchor element was used for anchorage of thermal insulating system (Fig. 3 and Fig. 4). In the base part the foundation thermal baseboard reducing significantly the line heat bridge was used (Fig. 4).

Fig. 4 Application of special thermal baseboard of thermal insulating system and arrangement of adhesive anchors on the wall with application of thermal insulating system

Transparent construction

Up to date commonly used windows are inconvenient for energy passive buildings. For such buildings the windows having thermal transmittance $Uw \leq 0{,}8$ W/(m^2.K) are to be used. In order to achieve such thermal transmittance value the window frame and casement cresting should have the U-value of $Uf \leq 1{,}0$ W/(m^2.K). Special Euro-prisms with thickness of $bf > 70$, where the middle bar is replaced by high-performance insulating material, are used in cresting on wooden material basis. Combined wood-aluminium basis, where the wooden part with high-performance insulating material bar is able to ensure the required U-value and to supplement a window in terms of architectural detail and functionality, is also considered as suitable.

The window transparent part - glazing, which forms 70 up to 80 % of window area, has decisive influence on its thermal insulating characteristics. In order to achieve the necessary thermal transmittance value of window the glazing should reach the value (depending on window dimensions) of $Ug \leq 0{,}6$ to 0,35 W/(m^2.K). The given value can be obtained by using the insulating triple-glazing with selective layers filled with krypton. As already mentioned, in correctly designed passive building there is a need to lay stress also on segmental elements (e.g. placement of window in building envelope). The building envelopes of passive buildings can have alternative design solutions (light wooden structure and thermal insulating material, heavy monolithic structure and thermal insulating material). The correct window imbedding in building envelope results from the above given variants. In the paper I deal with the window imbedding in heavy building envelope structure with a frame on unconventional material basis for passive buildings, and that is aluminium with heat bridge interruption. There are various alternatives of window imbedding in building envelope illustrated in Fig. 5. The composition of external wall from the interior towards exterior is as follows - plaster casting, concrete wall, thermal insulating material on polystyrene basis, thin film façade rendering system.

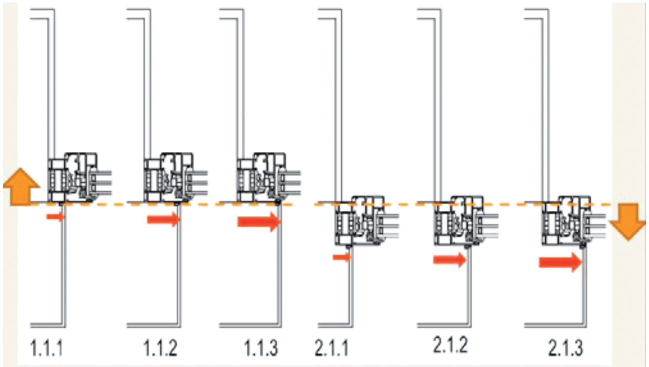

Fig. 5 Examination of the position of the window in the heavy outer wall

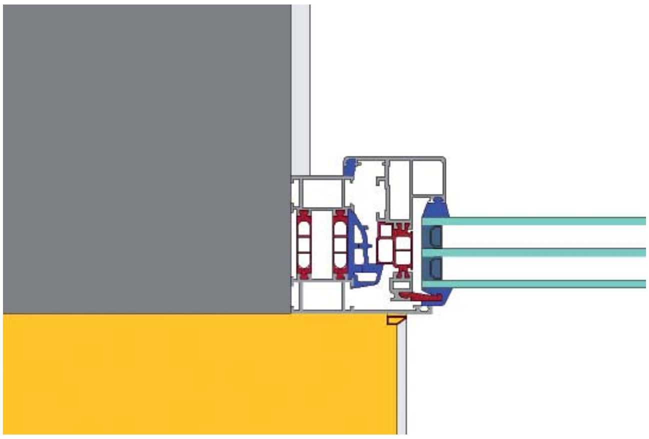

Fig. 6 Geometry of used aluminium window

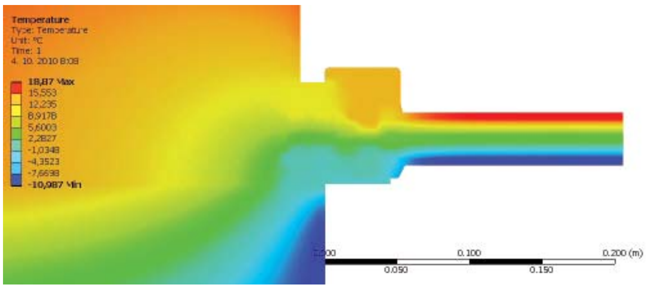

Fig. 7 Surface temperature - model 1.1.1 (-11 °C exterior, interior 20 °C)

Conclusions

In non-transparent parts of building envelope in energy passive standard it is not extremely demanding to comply with the requirement for low heat flows in a fragment. Considering the heat bridge areas it is necessary to optimise their structural design and thermal performance. In energy passive building the aluminium window structure is non-standard, but it can also be used. Due to the fact that aluminium frames consist of structure with hidden window frame it is possible to achieve interesting results by choosing appropriate detail insulation and window imbedding. It is evident from the computer models that model 2.1.3 is the most suitable one in terms of minimization of heat flows and heat losses. Also other factors (e.g. aesthetic solution, possibility of additional clap-net application, etc.) are to be taken into consideration in the decision making process. Considering all the factors the detail of window imbedding in building envelope was realized according to model 2.1.2 (Fig. 8).

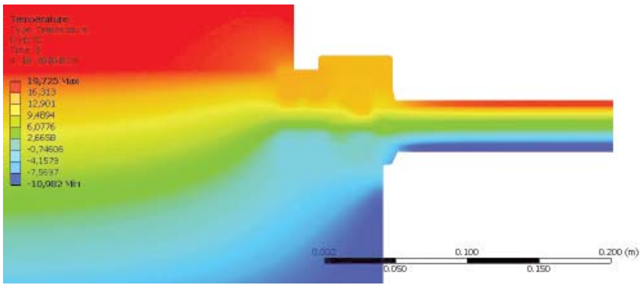

Fig. 8 Surface temperature - model 2.1.3 (-11 °C exterior, interior 20 °C)

Fig. 9 Surface temperature - model 2.1.3 (-11 °C exterior, interior 20 °C)

References

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